In recent years many amateurs have participated in systematic observations of the Perseids, and the number of doubly observed meteors has been greatly augmented. In July, 1900, three early Perseids were recorded in duplicate and gave heights and radiants as follow:—

	Height at beginning. Miles.	Height at end. Miles.	Radiant. ° °
July 19	81	54	17+50
,, 23	84	55	24+52
,, 30	95	50	30+52

In time it will be possible to accumulate a sufficient number of these observations to assign the radiant on every night during the last half of July. There will certainly be small errors in the individual positions, and they will not absolutely agree in showing the regular progression of the radiant eastwards, but the mean places derived from a considerable number of meteors will no doubt yield very satisfactory results.

In previous years much has been effected at the July and August epoch, but still more remains to be done. Photography, of which so much was expected, has achieved little, but its possibilities are great and it may ultimately prove as successful in this department as it has done in several others. The fact, however, remains that we are still mainly dependent upon eye observations, though they are no more than rough and hurried estimates of position, and scarcely capable of being usefully employed in any refined or critical investigations of the subject. But with care and long practice it is possible to acquire a degree of accuracy which would hardly have been credited, and we must not forget that some important conclusions have been safely based on rough eye observations. The virtual identity of comets and meteors has been established, the heights and velocities of meteors approximately determined, while the positions of some hundreds of radiants have been ascertained with fair accuracy. Features such as the motion of the Perseid centre, the stationary aspect of the Orionid and certain other radiants, and the large area of radiation of the meteors of Biela's comet, have been demonstrated. But much additional data are required, and as photography has hitherto supplied very meagre results, observers have to fall back upon the old-time method as vastly more productive if far less precise. It will be remembered that some years ago it was thought that the photographic plate would soon supersede the observer in regard to the delineation of planetary detail, but this idea has not been realised. It is true that planetary and meteoric observations are different and therefore not strictly comparable, but we have gained enough experience to see that the meteoric observer is in no immediate danger of being displaced.

W. F. DENNING.

THE "EDISON" STORAGE CELL.

CONSIDERABLE interest was aroused a short time ago by the announcement that Mr. Edison had invented a new secondary battery. As was only to be expected of a rumour, circulated mainly by the lay Press and dealing with one of Mr. Edison's inventions, it was said that the new cell was going to revolutionise entirely the electrical storage of energy and to throw open to the undisputed control of the electrical engineer the much-desired field of motor-car work. Fortunately, in this case, even if rumour has been somewhat extravagant, it has not been without foundation. Mr. Edison has in reality invented a new storage cell which is novel in principle and full of promise. A full description of the invention was given by Dr. A. E. Kennelly at the annual meeting of the American Institute of Electrical Engineers on May 21, and we are able, from a reprint of this paper which appeared in the *Electrical Review* of New York (May 25), to obtain data for a preliminary consideration of the merits of the cell.

Mr. Edison—like many other inventors, only with more success than is met with by most—set out with the object of devising a cell which should possess the following merits:—(1) Absence of deterioration by work, (2) large storage capacity per unit of mass, (3) capability of being rapidly charged and discharged, (4) ability to withstand careless treatment, and (5) inexpensiveness.

It will be best first to describe the solution that Mr. Edison has offered, and then to examine, as far as is possible from the information available, to how great a degree the above requirements are satisfied. The problem thus clearly stated by Dr. Kennelly is one which has been long realised by all interested in the matter, and by none, perhaps, more than by the makers and users of motor-cars. The one great difficulty in the construction of a good electrical motor-car, or in the equipment of a satisfactory system of accumulator tramways, has been the want of a suitable storage cell. If this were only provided, we have been told, then the electrical motor-car would know no rival, seeing that it would be free from all the objectionable noise and smell incidental to petroleum automobiles. It is, therefore, most earnestly to be hoped that the new Edison cell will do all that is claimed for it.

The cell is an entirely new departure in storage batteries, the materials used in its construction being iron and nickel oxide. The active material of the negative plate of the cell consists of iron, that of the positive plate of a superoxide of nickel believed to have the formula NiO_2. Thus the iron corresponds to the spongy lead and the oxide of nickel to the lead peroxide of a lead accumulator. The electrolyte used is an aqueous solution containing about 20 per cent. by weight of caustic potash. The E.M.F. of this combination—iron, potassium hydrate, nickel superoxide—is about 1·5 volts when fully charged and falls to about 1·15 at the end of the useful discharge. At the end of the discharge the iron is oxidised and the nickel oxide reduced; the charging process carries back the oxygen through the potash solution from the iron to the nickel plate, the energy being thus stored in the reduced iron, which, though unaffected by the solution in ordinary circumstances, is reoxidised when the cell is allowed to discharge. The solution, therefore, does

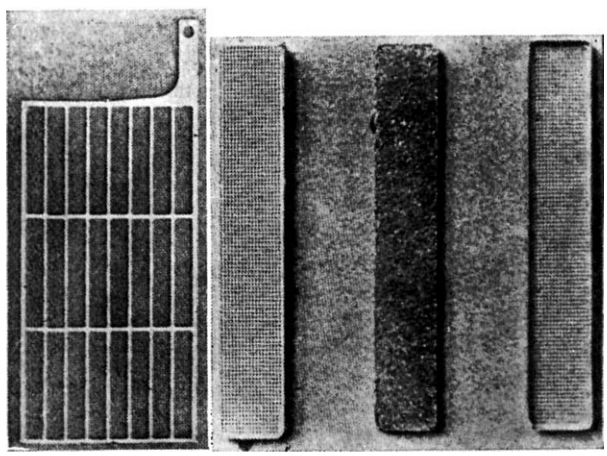

FIG. 1.—Grids and Briquettes, Edison Storage Battery. (From *The Electro-Chemist and Metallurgist*.)

not apparently enter at all into the chemical action which takes place, but only serves as a vehicle for transporting oxygen from the one plate to the other; this is of considerable advantage, as it allows a minimum of solution to be employed.

The mechanical construction of the two plates is identical, the only difference between them being in the active material used. The plates are made of comparatively thin sheets of steel (a little more than 0·5 mm. thick), out of which rectangular holes or "windows" are stamped. In the plates exhibited there were three rows of eight such windows, these holes occupying, of course, by far the greater proportion of the area, the steel framework being merely sufficient for strength and rigidity. Into these holes are fitted small nickel-plated steel boxes containing the active material in the form of closely consolidated briquettes. These boxes are somewhat thicker than the grid, being about 2·5 mm. thick in the finished plate, and are perforated, back and front, with numerous small holes to allow access of the electrolyte to the active material. The general appearance of the grid and briquettes can be seen from Fig. 1.

The positive briquettes are made by mixing a finely divided compound of iron with a nearly equal volume of thin flakes of graphite, the graphite being added to increase the conductivity of the briquettes. The mixture is pressed in a mould under an hydraulic pressure of about two tons per square inch. The surface area of each face of the briquette is about 3 inches by ½ inch. The negative briquettes are made in a precisely similar

way, only a compound of nickel is used in place of the compound of iron. The method by which these compounds are obtained and their constitution was not described in Dr. Kennelly's paper, but from the patent specification it appears that the compound of iron used is the monosulphide, FeS, which is formed after being made up into the briquettes by electrolytic oxidation in a solution of potassium hydroxide. The superoxide of nickel is prepared in the same manner by electrolytic oxidation of the ordinary hydrated oxide of the metal. Cobalt, it is said, can be used instead, but is more expensive. The briquettes of active material are placed in the little nickel-plated steel boxes, a cover is put on, and the boxes are then inserted in the "windows" of the grid. The assembled plate is then subjected in an hydraulic press to a pressure of about 100 tons (about 1 or 1½ tons per square inch), thus tightly closing the boxes and, by bending their sides over the edges of the recesses in the grid, fixing them firmly in position and making the whole into a rigid plate. The plates are separated, positive from negative, by thin perforated sheets of hard rubber, and are placed in a steel box which is filled up with the potash solution. The cell is then charged by passing current through it from the nickel to the iron plate, thus oxidising the nickel compound to superoxide of nickel and reducing the iron compound to spongy metallic iron.

It is obviously impossible to say at present how far this cell will satisfy the five conditions already stated. With regard to the first and the last, for example, no data are as yet available. The first is naturally one of the most important considerations, since it is necessary not merely that the cell should have a long life, but that it should not deteriorate too much even when subjected to somewhat careless treatment, as it is certain to be if it come into at all general use for motor-cars. Certain experiments which were quoted by Dr. Kennelly lead, however, to the hope that the cell will not be found wanting in this respect. Thus it was stated that the battery would stand without injury, not only being completely run down, but even being afterwards charged in the wrong direction. Mr. Edison also states that the nickel plate can be removed from the cell and dried in the air for a week without being injured, and if charged when thus removed will not appreciably lose its charge. The iron plate, if similarly treated, will lose its charge by the slow oxidation of the spongy iron, but will not be in any way permanently injured.

Perhaps the consideration that appeals most directly to motor-car users is lightness, or large storage capacity per unit weight. In this respect the cell compares very favourably with lead accumulators. According to Dr. Kennelly the storage capacity of the modern lead accumulator is from 4 to 6 watt-hours per lb., or from 9 to 13 watt-hours per kilogramme, whereas the Edison cell is said to have a capacity of 14 watt-hours per lb. (31 watt hours per kilogramme). It will be interesting to examine these figures a little more closely to see whether this claim to an increased storage capacity of about 3½ times is in reality justified. We reproduce in Fig. 2 a discharge curve for an Edison cell weighing 25lbs., discharging at 42·5 amperes for six hours. It will be seen that after five hours' discharge the voltage drops from 1·45 to 1·0 volt; although it may be possible to obtain the remaining hour's discharge without injury to the cell, yet it is very questionable whether this extra energy at so low a voltage as 0·5 volt would be found useful in practice. We are quite justified in saying, therefore, that this cell is only capable of giving five hours' discharge at 42·5 amperes, thus having a capacity of 213 ampere-hours, or 260 watt-hours. It has, therefore, a capacity of 10 watt-hours per lb. (22 per kilogramme), a figure somewhat lower than that given by Dr. Kennelly in the body of his paper. In an article on accumulators which appeared recently in the *Electro-Chemist and Metallurgist* (May 1901, p. 116), Mr. J. H. West gives a carefully calculated table of the capacities of all the principal accumulators exhibited at the Paris Exhibition or which took part in the Automobile Club competition of 1899. We can take from this table the figures relating to accumulators having a capacity of 200 ampere-hours and discharging in five hours, which are exactly comparable, therefore, with the Edison cell, the discharge curve of which is given in Fig. 2. Calculating from these data we get the results given in the accompanying table; there are 19 cells included in Mr. West's list, but as some of these are heavy cells intended for stationary work, a mean result has been worked out in which the heavier cells are neglected as well as a mean for the whole number.

TABLE.

Cell	Energy stored: Watt-hours per kilogramme	Energy stored: Watt-hours per pound
Mean of all cells in Mr. West's table	7	3
Mean of lighter cells ,, ,,	13	6
Lightest cell (Sherrin) ,, ,,	26	12
Edison's cell, from curve	22	10
,, ,, Dr. Kennelly's figures...	31	14

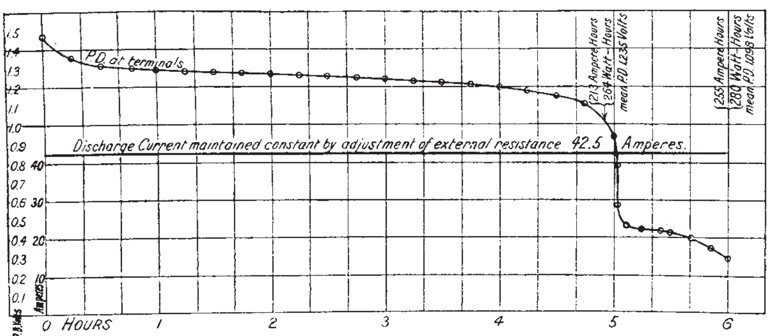

FIG. 2.—Curve of discharge of Edison cell weighing 25 pounds.

As the figures given by Mr. West only refer to ampere-hours, we have assumed in calculating the table that the mean voltage during discharge is 1·85 volts, a somewhat low estimate, and one therefore favouring the Edison cell in the above comparison. It will be seen from this table that the Edison cell when compared with the lightest lead accumulator obtainable is by no means so pre-eminent as regards energy capacity per unit weight. The Sherrin cell, it may be remarked, came very successfully through the Automobile Club's competition, being the only one which did not fall below the specified voltage more than three times during the trials. Although the figures given above may seem to militate against the claims advanced in favour of the new battery, it must be remembered that high storage capacity is not the only advantage that it is said to possess; even if it were no better than lead cells in this respect, if it proves superior to them in the other four conditions it will be a great advance. Also it must not be forgotten that the cell is quite new and that no doubt great improvement may be looked for when it is produced in large quantities.

THE BIOLOGY OF MOUNT SHASTA.

THE results of a biological survey of Mount Shasta, California, are contained in a *Bulletin*[1] recently received. This publication of 169 pages, with forty-six text illustrations and five heliotype plates, is a worthy successor to its forerunners, now so well known, and in every respect equal to the best of them.

It is the result of an investigation by the Biological Division of the U.S. Department of Agriculture under Dr. C. Hart Merriam, chief of the Biological Survey, which was decided upon in 1898, after the completion of the exploration of southern, middle, and north-east portions of the vast Californian area. The great altitude of the mountain (14,450 feet), and its position between the Sierra Nevada and the Cascades of

1 "North American Fauna," No. 16. U.S. Department of Agriculture. Washington: Government Printing Office, 1899.)